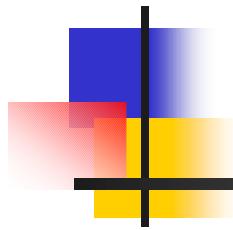
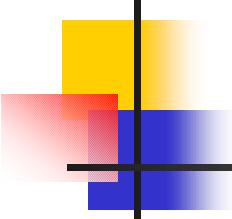


LQ search in eejj channel



Simona Rolli (TUFTS)
-blessing-

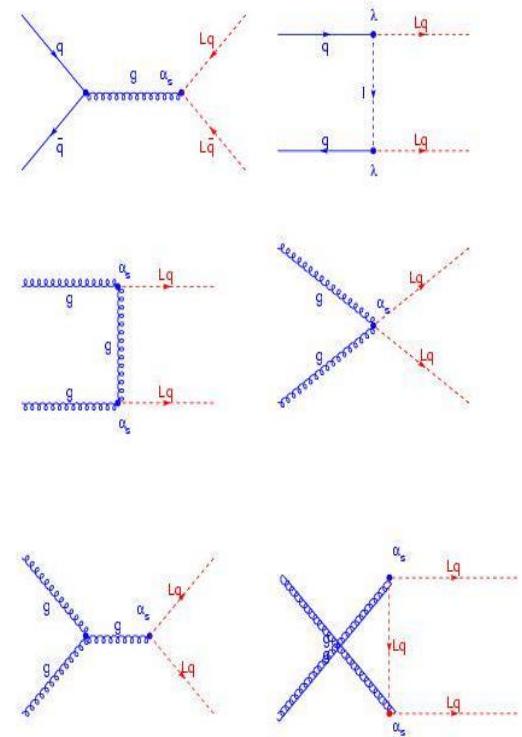


Issues from preblessing

- Systematic uncertainty
 - Jet energy corrections
 - Applied time dependent, Energy scale, Relative corrections – effect on acceptance small
- Isolation cut over efficiency ?
 - Checked on signal MC – same as data
- Z CC candidate events – checked with Z' – agreement now

Introduction

- Some beyond the SM models assume additional symmetry between leptons and quarks
 - Production
 - $qg \rightarrow LQ + L\bar{Q}$
 - $gg \rightarrow LQ + L\bar{Q}$
 - $q\bar{q} \rightarrow LQ + L\bar{Q}$
 - Decay - $\beta = \text{Br}(LQ \rightarrow e\bar{q})$ -
 - $LQL\bar{Q} \rightarrow l^+l^-q\bar{q}, l^\pm n\bar{q}q, nn\bar{q}\bar{q}$
 - Experimental signature:
 - High pt isolated leptons and/or MET + jets



Theoretical predictions

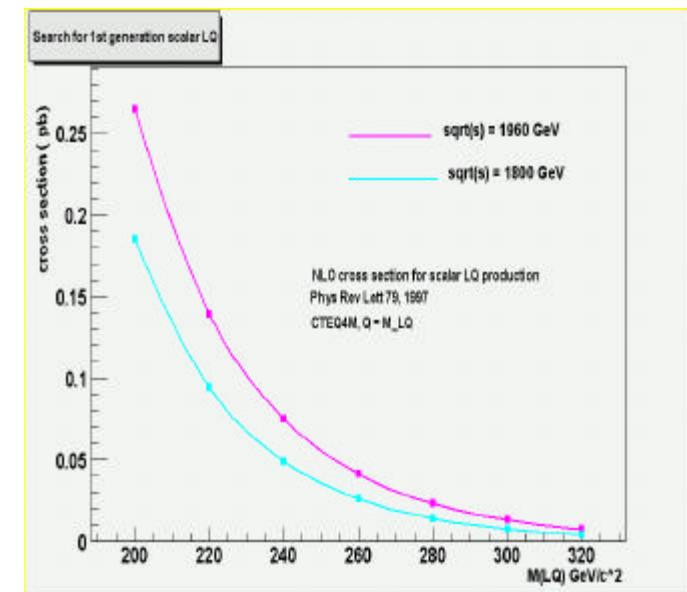
Code from Michael Kraemer (Phys.Rev.Lett 79,1997)

M_{LQ} (GeV/c^2)	$\sigma(\text{NLO})$ [pb]
200	0.185E+00
220	0.094E+00
240	0.489E-01
260	0.259E-01
280	0.138E-01
300	0.746E-02
320	0.401E-02

M_{LQ} (GeV/c^2)	$\sigma(\text{NLO})$ [pb]
200	0.265E+00
220	0.139E+00
240	0.749E-01
260	0.412E-01
280	0.229E-01
300	0.129E-01
320	0.727E-02

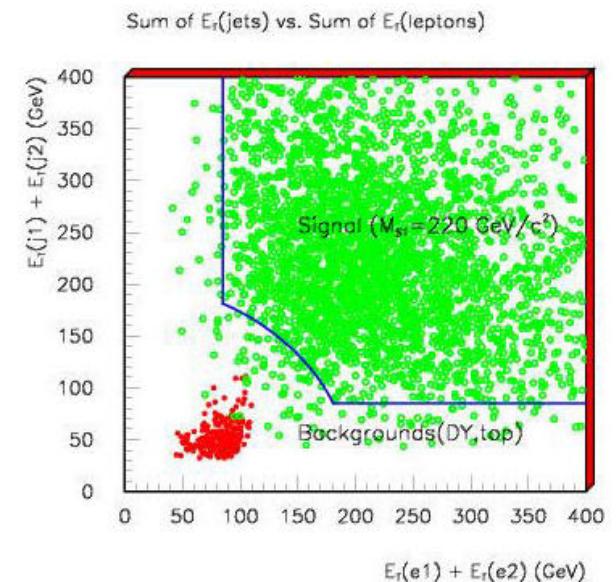
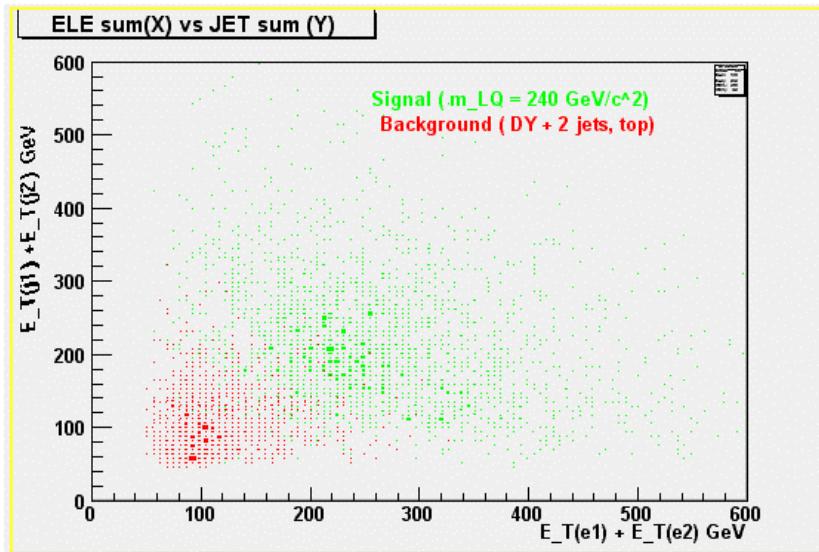
$\sqrt{s} = 1800 \text{ GeV}$
 $Q^2 = M_{LQ}^2$
CTEQ4M pdf

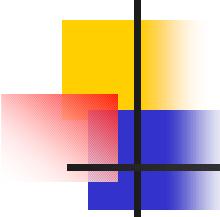
$\sqrt{s} = 1960 \text{ GeV}$
 $Q^2 = M_{LQ}^2$
CTEQ4M pdf



LQ search in eejj

- 2 central electrons with $E_T > 25$ GeV
- 2 jets with $E_T(j1) > 30$ and $E_T(j2) > 15$ GeV
- removal of events with $76 < M_{ee} < 110$ GeV
- $E_T(j1) + E_T(j2) > 85$ GeV $\&\&$ $E_T(e1) + E_T(e2) > 85$ GeV
- $\tilde{\Omega}((E_T(j1) + E_T(j2))^2 + (E_T(e1) + E_T(e2))^2) > 200$ GeV

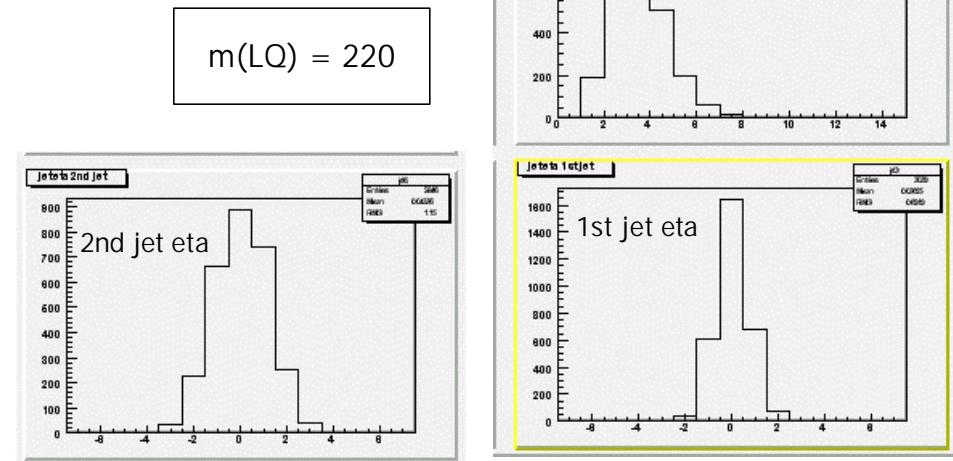
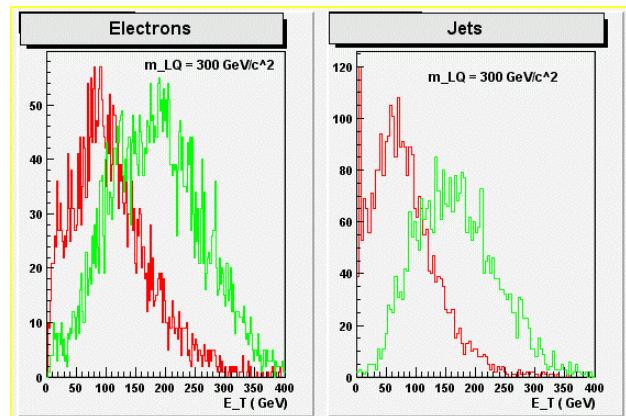
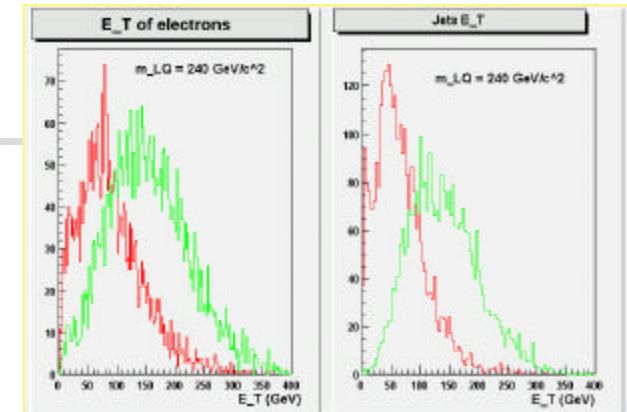
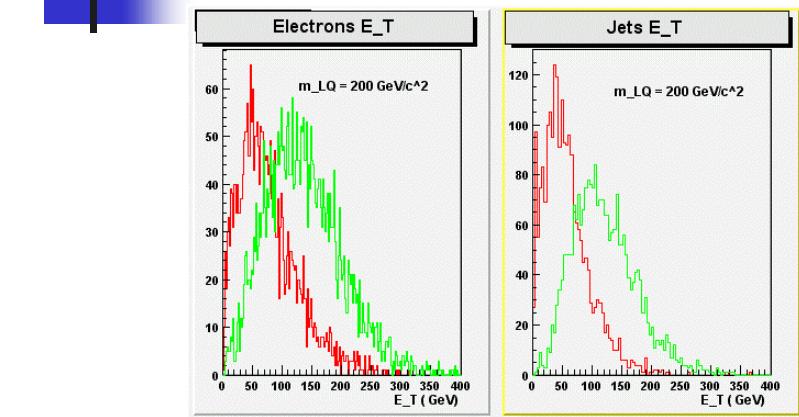


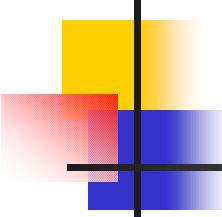


Tools

- Signal generated and reprocessed with 4.9.1
 - 5000 events at masses from 200 to 320
 - run number 151435
 - full beam position
 - talk GenPrimVert
 - BeamlineFromDB set false
 - sigma_x set 0.0025
 - sigma_y set 0.0025
 - sigma_z set 28.0
 - pv_central_x set -0.064
 - pv_central_y set 0.310
 - pv_central_z set 2.5
 - pv_slope_dxdz set -0.00021
 - pv_slope_dydz set 0.00031
 - exit
- eN (4.9.1)used for ntuple analysis
 - <http://ncdf70.fnal.gov:8001/talks/eN/eN.html>

MC distributions



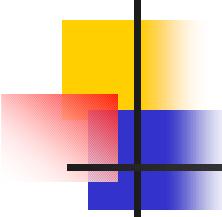


Efficiencies & acceptance

$$\epsilon_{\text{tot}} = \epsilon_{\text{Acc}}(M) \times \epsilon_{\text{ID}} \times \epsilon_{z0} \times \epsilon_{\text{trig}}$$

- Trigger
 - Top/EW - as in Z' analysis we use $99.1 \pm 0.1\%$
- Efficiencies for electron selection cuts
 - Z' analysis
 - $\epsilon_{\text{CC}} = 83.2 \pm 0.8$
- Other
 - efficiency on the vertex cut ($|z_0| < 60$ cm) 95.2 ± 0.1 (stat) ± 0.5 (sys) (Willis Sakumoto)

Changed from preblessing



Electron ID (Z' analysis)

- Central electron (loose or tight)

- $E_t \geq 25 \text{ GeV}$
- $p_t > 10 \text{ GeV}$
- hadem $\leq 0.055 + 0.00045 * E$
- $E/p < 4$ (for $E_T < 200 \text{ GeV}$)
- iso4e/emet < 0.1 (0.2 for second central loose)
- $|\Delta x| < 3.0$
- $|\Delta z| < 5.0 \text{ cm}$
- Fiducial = 1
- Ishr < 0.2

$$\epsilon_{CC} = 83.2 \pm 0.5\%$$

$$\epsilon_{CP} = 69.3 \pm 0.8\%$$

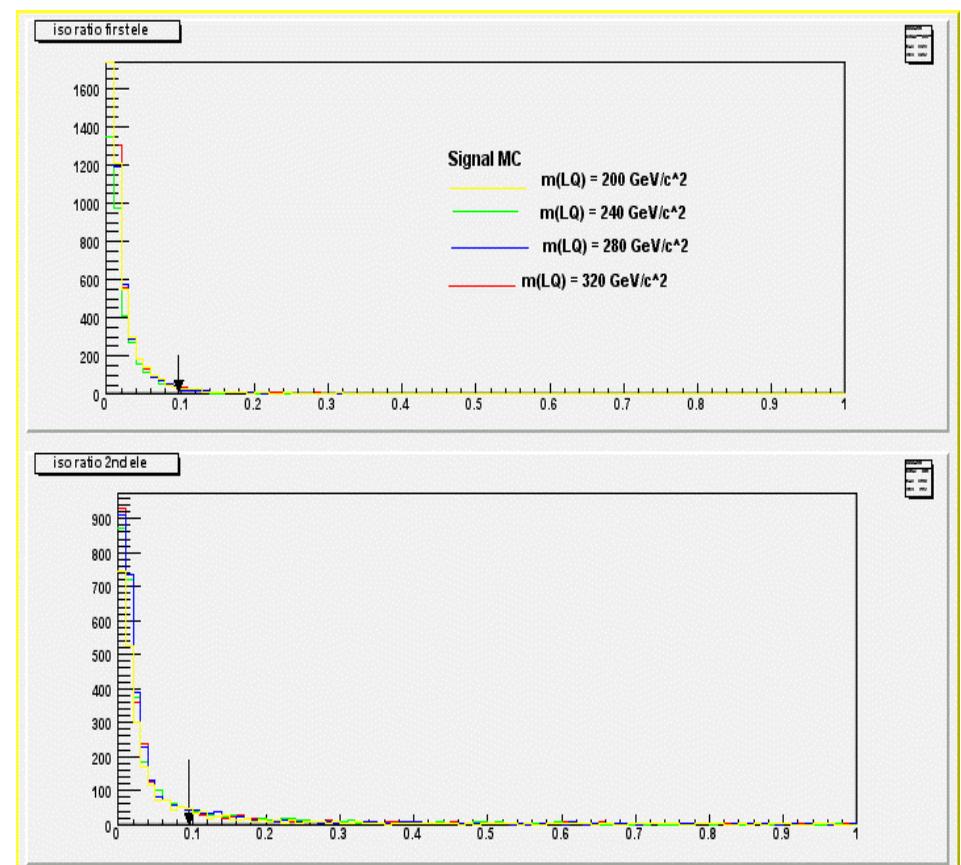
Second Loose Plug electron
(not used in this analysis)

- $E_t \geq 25 \text{ GeV}$
- Isolation < 0.1
- hadem $\leq 0.055 + 0.00045 * E$
- Fiducial $1 < |\eta| < 3$

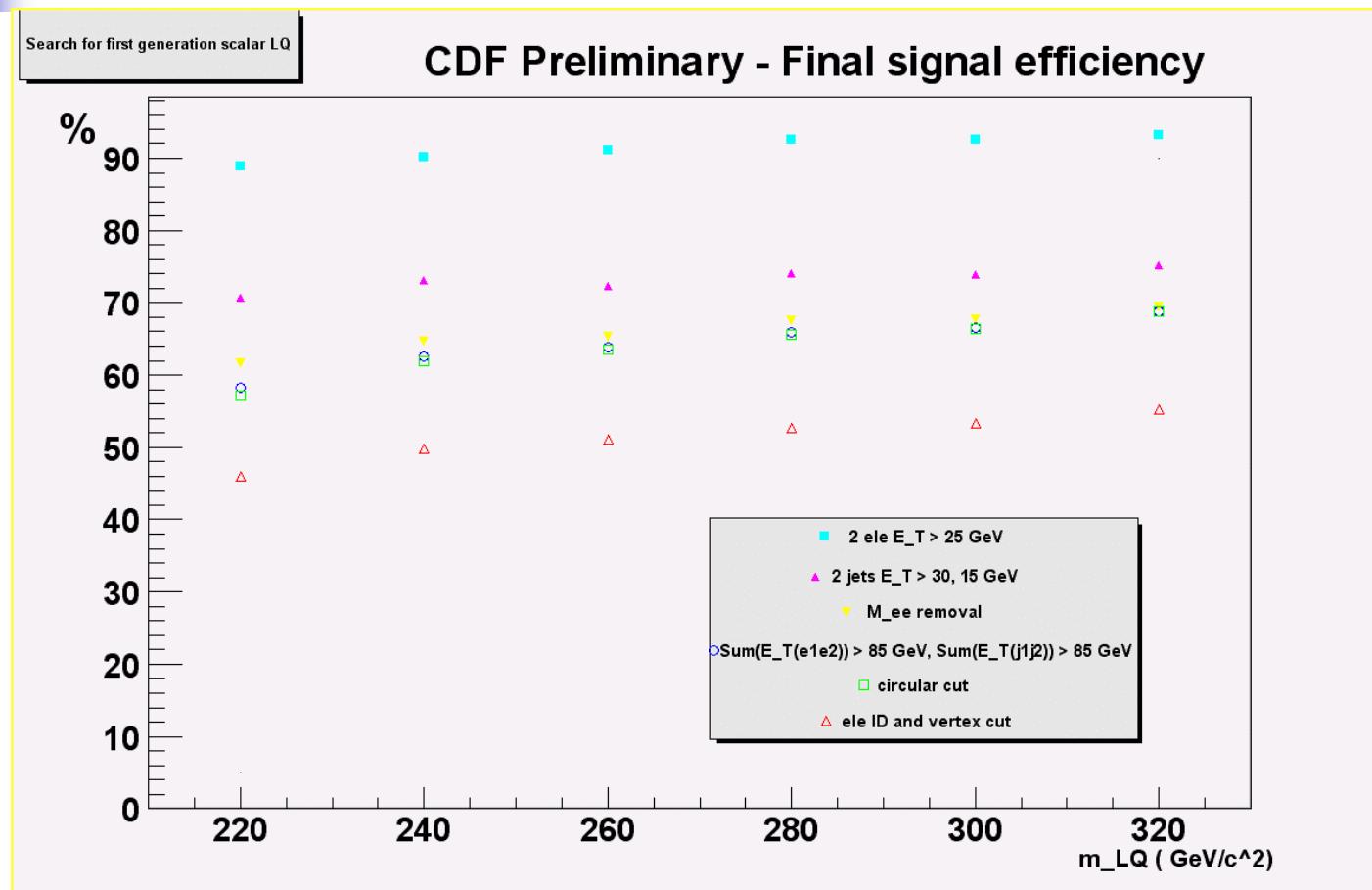
Isolation cut

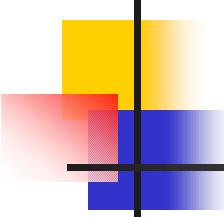
- LQ decay into an electron and jet
- Isolation from Z sample could be over efficient
- Isolation efficiency from MC:

M(LQ)	eff
200	0.974 ± 0.003
240	0.972 ± 0.003
280	0.973 ± 0.003
320	0.975 ± 0.003
- Iso eff from cdfNote 6262
 0.976 ± 0.005



Total acceptance

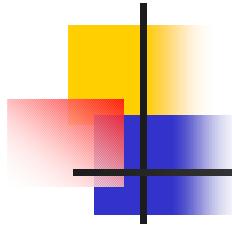




Expected signal events

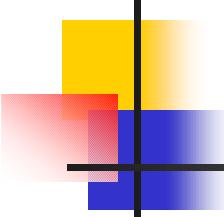
Number of
expected events
in 72 pb^{-1}

Mass (GeV/c^2)	n Theory CTEQ4M (pb)	n Theory CTEQ4M (pb)
	$Q^2 = M_{\text{LQ}}^2/4$	$Q^2 = 4M_{\text{LQ}}^2$
200	8.768	7.07
220	4.89	3.95
240	2.86	2.3
260	1.62	1.29
280	0.93	0.74
300	0.54	0.43
320	0.32	0.25



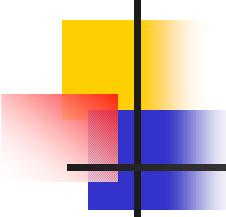
Background

- tt with both $W \rightarrow e\nu$ 0.25 ± 0.03 events
 - pythia
- DY + 2 jets 3.13 ± 2.8 events
 - alpgen + PS
- Total 3.39 ± 3.15



Data sample

- btop0g (inclusive electrons) stripped from bheI08 and (4.8.4 Production)
- Inclusive-ele_484_REMAKE
- events selected from Ele_18 && Ele_70 triggers
- good runs from March 23 2002 to Jan 12 2003 (141544 - 156487)
- $70.2 \text{ pb}^{-1} \times 1.019$
 - 2 isolated electrons
 - One tight (central)
 - One loose (central)
 - At least 2 energetic jets



Data sample

```
module clone Prereq HPTE
module enable Prereq-HPTE
module talk Prereq-HPTE
L1Accept set true
L2Accept set true
L3Accept set false
L3TriggerNames set ELECTRON70_L2_JET \
                 ELECTRON_CENTRAL_18 \
                 ELECTRON_CENTRAL_18_NO_L2 \
                 W_NOTRACK \
                 W_NOTRACK_NO_L2 \
                 Z_NOTRACK
debug set false
exit
exit
```

```
module clone StripSingleE HPE2
module enable StripSingleE-HPE2
module talk StripSingleE-HPE2
elePtMin set 15.0
etCalMin set 70.0
delXMin set 3.0
delZMin set 5.0
show
exit
```

```
module clone StripSingleE HPE1
module enable StripSingleE-HPE1
module talk StripSingleE-HPE1
elePtMin set 9.0
etCalMin set 18.0
delXMin set 3.0
delZMin set 5.0
EoPMax set 4.0
lshrMax set 0.3
hademMax set 0.125
show
```

Z cross section check

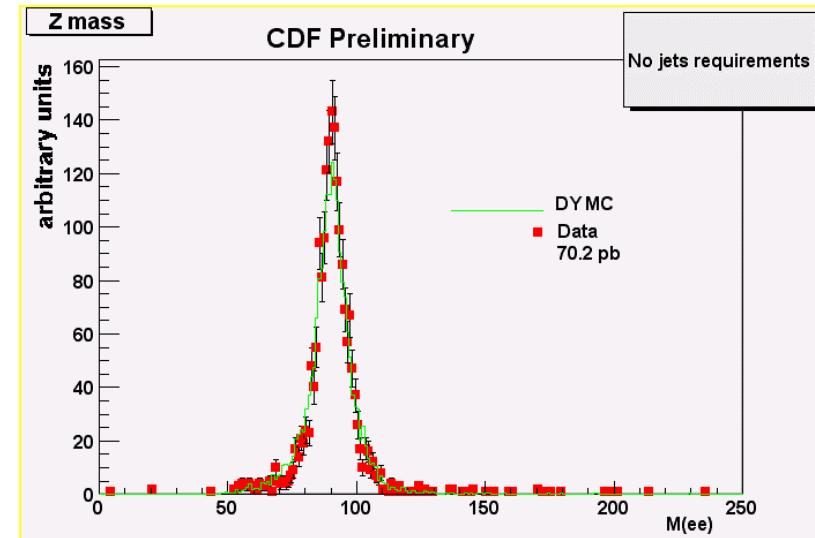
- Z boson candidates selected by requiring:

$$70 \text{ GeV} < M_{ee} < 110 \text{ GeV}/c^2$$

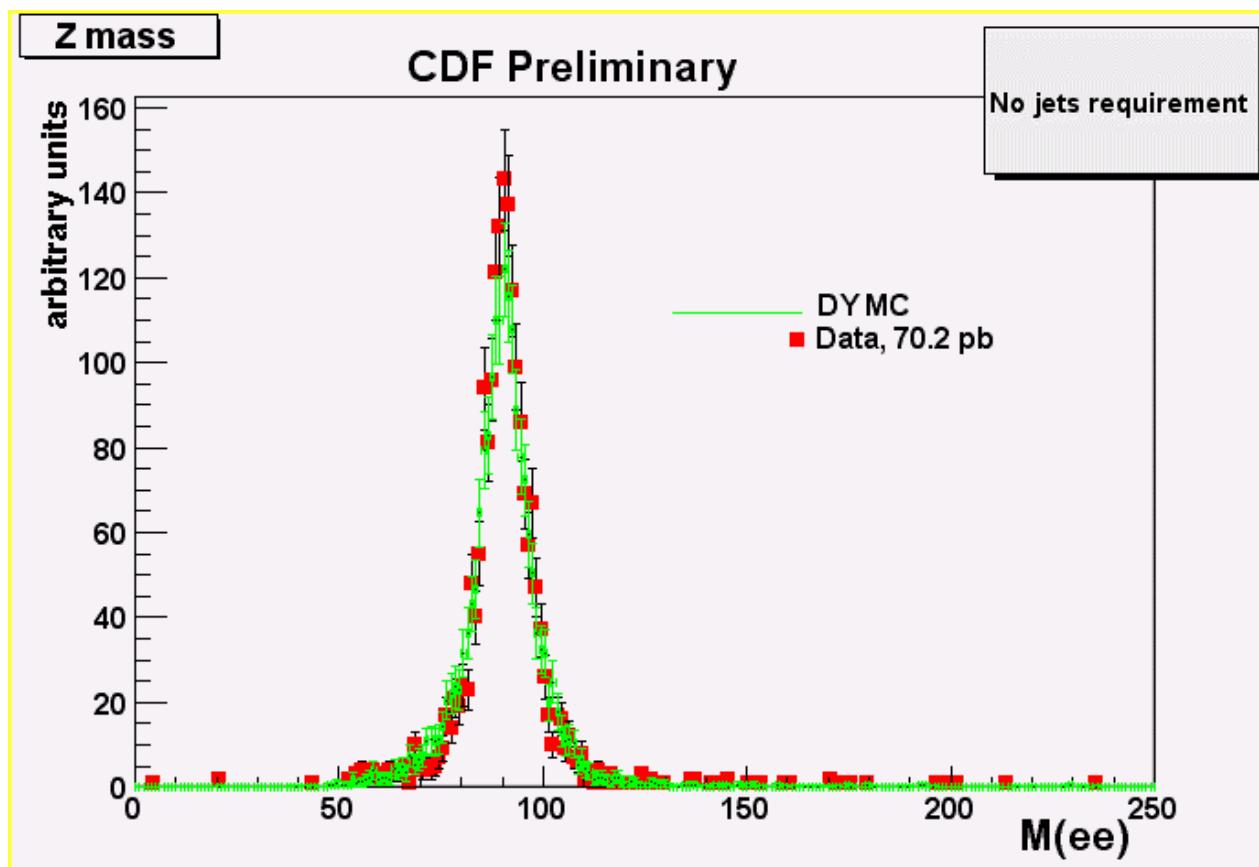
- Central-Central candidates: 1806
- Cross section is calculated as:

$$s' \text{Br} (\text{pp} \rightarrow Z \rightarrow e^+ e^-) = (N_Z - N_{\text{BG}}) / (A_Z \cdot e_{\text{ID}} \cdot e_{\text{trig}} \cdot e_{z0} \cdot L)$$

Acceptance	$11.5 \pm 0.7\%$
ID efficiency	$83.2 \pm 0.5\%$
trigger efficiency	$99.9 \pm 0.1\%$
Z_0 efficiency	$95.2 \pm 0.5\%$
Observed events	1806
estimated bkg	34.8 ± 21.1
integrated L	71.5 ± 0.5
Z cross section	$270.34 \pm 15.4 \text{ pb}$



Z mass

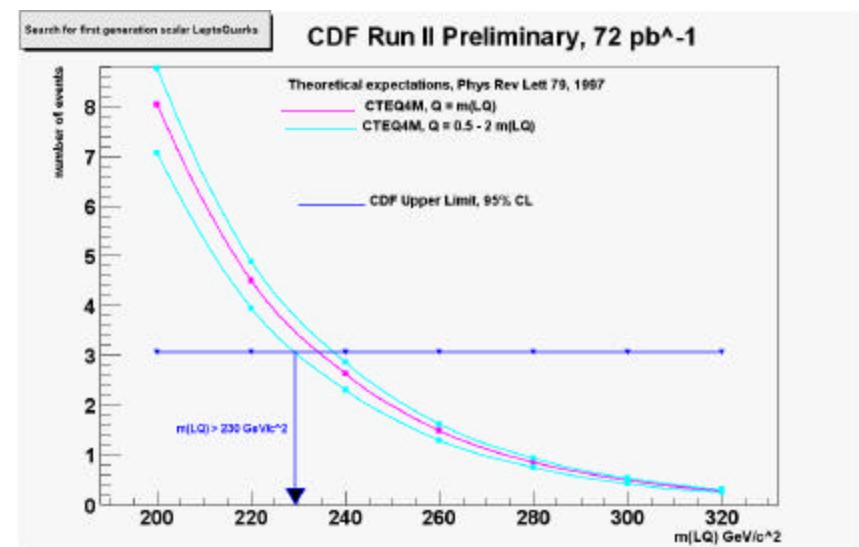


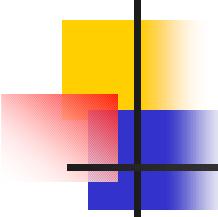
Analysis results

0 events survive the analysis cuts:

Number of events with 2 ele > 25	1970
2 jets with $E_T(j1) > 30$ and $E_T(j1) > 15$ GeV	26
removal of events with $76 < M_{ee} < 110$ GeV	9
$E_T(j1) + E_T(j2) > 85$ GeV $\&\&$ $E_T(e1) + E_T(e2) > 85$ GeV	2
$\sqrt{(E_T(j1) + E_T(j2))^2 + (E_T(e1) + E_T(e2))^2} > 200$ GeV	0

$M_{LQ} > 230$ GeV @ 95% CL





Cross section limit

For blessing

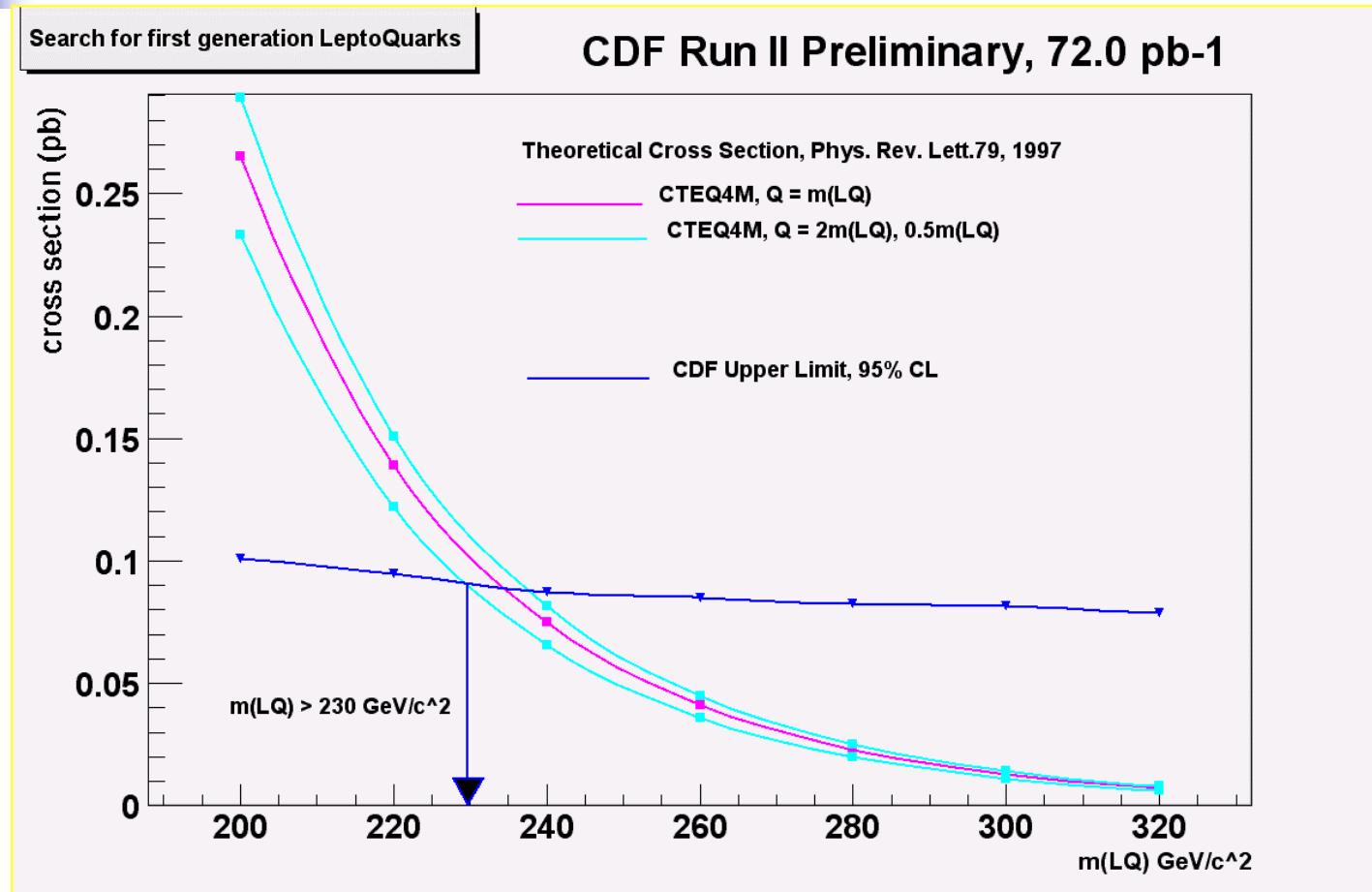
Mass (GeV/c ²)	95%CL σ (pb)	σ Theory CTEQ4M (pb)	σ Theory CTEQ4M (pb)
		$Q^2 = M_{LQ}^2/4$	$Q^2 = 4M_{LQ}^2$
200	0.101055	0.2890	0.2330
220	0.0945771	0.1510	0.1220
240	0.0872671	0.0815	0.0657
260	0.0850378	0.0449	0.0360
280	0.0823698	0.0250	0.0200
300	0.0813719	0.0141	0.0112
320	0.0786428	0.00799	0.00629

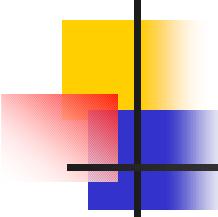
Values of the upper limits at 95% CL of the production cross section of first generation leptoquarks decaying into eejj channel as a function of M_{LQ} . The last 2 columns on the right report the result of the theoretical calculations at Next-To-Leading order with CTEQ4M for different choices of the scale, multiplied by a factor $\beta \times \beta = 1$.

For blessing

25% increase in the cross section
~factor 1/3 less luminosity
acceptances slightly higher

Cross section Limit

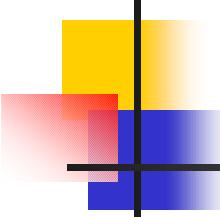




Systematic uncertainties

- Luminosity: 6%
- Acceptance
 - pdf 4.3% (from run I)
 - statistical error of MC 2.2%
 - jet energy scale (Level 3) 2.9 - 0.7 % (absolute uncertainty)
 - jets corrected for energy scale, time dependent and relative response
 - jet energy scaled of systematic uncertainty + 4.2% (energy scale run I/run II) + 5% data/MC adjustment ;
- Electron ID efficiency (Z')
 - statistical error of $Z \rightarrow e^+e^-$ sample: 0.8%
 - energy scale : 3.7%
- Event vertex cut : 0.5% (Willis)

Final relative
uncertainty on
acceptance 9%



Conclusions

- A preliminary 95% CL cross section lower limit as a function of M_{LQ} , for leptoquarks decaying with 100% branching ratio into eq ($\beta = 1$) has been set.
- Comparing it to the NLO theoretical predictions for leptoquark pairs production at the TeVatron, an upper limit on the Leptoquark mass is obtained at

$$m_{LQ} > 230 \text{ GeV}/c^2$$

- consistent with run I limit at $220 \text{ GeV}/c^2$